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ABSTRACT

A study investigated the relationship between text organization and children's reading comprehension of expository material. Upgraded and downgraded versions of both macrostructures and microstructures were combined to produce four texts on the topic of insect-eating plants. Forty-three seventh grade students were randomly assigned to one of the four text conditions. The results from reading comprehension, prior knowledge, and vocabulary tests were used as pretest measures, while various posttest measures were designed to be sensitive to particular text structure manipulations. An analysis of covariance using a hierarchial regression technique suggested that students benefitted from reading text that was written to highlight comparisons among concepts presented in the passage. (Author/FL)

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CENTER FOR THE STUDY OF READING

Technical Report No. 316

EFFECTS OF TEXT STRUCTURE ON CHILDREN'S COMPREHENSION OF EXPOSITORY MATERIAL

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Abstract

The relationship between text organization and childrens' reading comprehension of expository material was investigated. Text organization manipulations involved macrostructures as outlined in Peters (1975-1976) and Frayer, Fredrick, and Klausmeier (1969) and microstructures as described in Davison and Kantor (1982). Upgraded and downgraded versions of both macro- and microstructures were combined to produce four texts on the topic of insect-eating plants. Each of the 43 seventh-grade students attending a midwestern university-affiliated laboratory school were randomly assigned to one of the four text conditions. The results from a reading comprehension, prior knowledge, and an Anderson-Freebody vocabulary test (Anderson & Freebody, 1981) were used as pretest measures. The various posttest measures were designed to be sensitive to particular text structure manipulations. An analysis of covariance using a hierarchial regression technique suggests that students benefit from reading text that is written to highlight comparisons among concepts presented in the passage (i.e., upgraded Frayer-like manipulations). The results of other recent research relevant to this issue are compared with the present study. Finally, both implications and plans for future research are considered.

Effects of Text Structure on Children's Comprehension of Expository Material

A myriad of factors have been found to influence reading comprehension. Text organization or structure has been suggested to influence both reading comprehension and recall (Meyer, 1977a, 1977b; Taylor, 1982). Text structure has been broken down into two major categories, macrostructure and microstructure. The present study examined the unique and interactive contributions of both of these aspects of text structure on children's comprehension of expository text. Expository text was chosen since children tend to experience more difficulty understanding and remembering the kind of expository material found in content textbooks than narrative material (Taylor, 1982; Taylor & Berkowitz, 1984). In particular, since some (e.g., Armbruster, & Anderson, 1980) have argued that children's expository texts are often not well-organized, we were especially interested in whether better micro- or macrostructural organization would facilitate comprehension.

Among attempts to identify how information is organized in text (e.g., Mandler & Johnson, 1977; Propp, 1958; Thorndyke, 1977) is Kintsch & van Dijk's (1978) notion of macrostructure. Macrostructures are global structures that arrange local features (i.e., microstructures) of text (van Dijk, 1980). According to Kintsch and van Dijk, readers remember ideas in text by forming their own versions of the macrostructure or "gist" of important

text information. Macrostructure aids the reader's recall of detailed text information in addition to making salient information more memorable (Meyer, 1977a, 1977b; Rumelhart, 1975).

The notion that sensitivity to text structure plays an important role in reading comprehension is supported by recent research (Meyer, Brandt, & Bluth, 1980; Taylor, 1980, 1982). Taylor (1982) has found that children who fail to demonstrate sensitivity to text structure appear to remember less of what they have read than children who do demonstrate this sensitivity. However, sensitivity to text structure is possible only to the extent that the text permits the discovery of its structure. Therefore, presenting students with well-structured information may aid them in forming their own internal macrostructure, which should, in turn, aid in retrieving information at a later time.

We took a fairly pragmatic view of macrostructure, opting for the framework provided by concept acquisition researchers rather than more recent theoretical perspectives. Specifically, we selected the work of Frayer, Fredrick, and Klausmeier (1969) who have formulated a model of concept development designed to facilitate readers' recognition of main ideas as well as supporting details. The Frayer model defines concepts by identifying their relevant and irrelevant attributes, examples, and nonexamples and related concepts. A number of studies (e.g., Golub, Fredrick, Nelson & Frayer, 1971; Markle & Tiemann, 1969; Romberg, Steitz & Frayer, 1971; Tabachnick, Weible &

Frayer, 1970; Voelker, Sorenson & Frayer, 1971) support the hypothesis that an analysis of a concept in terms of its attributes, examples, and relationship to other concepts is useful in specifying what concepts are and are not. This method of concept analysis also aids readers in understanding the great variability among concepts.

Peters (1975-1976) investigated the effect of systematic restructuring of expository text on readers' comprehension within the Frayer-macrostructure framework. The experiment attempted to ascertain whether texts written according to the Frayer model of concept development were easier to understand than were conventional textbook approaches to concept presentation. The results indicated that both good and poor readers understood Frayer texts better than conventional texts. Our perspective on how to arrange for alterations in a text's microstructure comes from Davison and Kantor (1982), who have argued that text difficulty may be related to specific microstructural features of text. Features that may play an important part in concept learning include point of view, clause connectives, content information, topic and focus, and the appropriateness of vocabulary for a particular audience reading with limited background knowledge.

One other perspective guided our thinking. It is a transparent observation that prior knowledge influences comprehension (e.g., Freebody, & Anderson 1982; Pearson, Hansen, & Gordon, 1979). What is not so obvious is the possible trade-

off that might exist between prior knowledge and a text's "considerateness" (Kantor, 1980); i.e., whether a considerate text will compensate for a student's lack of prior knowledge. If so, then we should find that the gap between knowledgeable and less knowledgeable students' comprehension is narrower in considerate than in inconsiderate text.

The present study was motivated primarily by Peters's (1975-1976) research. First, we were interested in the fact that both good and poor readers, utilizing material structured according to the Frayer et al. (1969) model, had a higher degree of comprehension than good and poor readers who read text that was structured unsystematically. We decided to extend Peters's methodology by considering the influence of text microstructure, students' vocabulary ability, and prior knowledge on reading comprehension. Second, we attempted to investigate the relationship between increased concept learning and increased number of semantic cues provided by the Frayer model. We wondered whether these additional elements facilitated students' ability to remember information. Third, we were interested in determining whether the content utilized in the science material would produce results similar to those Peters found for social science material.

Method

Subjects

Fifty seventh-grade students enrolled in two science classes at a university lab school were asked to participate in the

study. A total of seven subjects were removed from the study: six for missing pre- or posttest measures; and one non-native student, for apparent language difficulties. Scores from the Iowa Test of Basic Skills (1975), i.e., subtest scores for vocabulary and reading comprehension, were obtained and used as a measure of general reading ability. Subjects retained in the present study had a range of grade equivalent scores on the reading comprehension subtest between 4.6 to 12.0 with a mean of 8.4 and standard deviation of 1.9. No significant differences between experimental conditions were found with respect to any of the pretest measures or the reading comprehension subtest scores.

Materials

Materials included: (a) a pretest of readers' vocabulary knowledge, (b) a pretest to assess readers' background knowledge of insect-eating plants, (c) four texts about insect-eating plants, (d) a free-response posttest aimed at measuring the Frayer et al. (1969) macrostructure manipulations, (e) a multiple choice posttest aimed at measuring the microstructure manipulations, and (f) an information matrix posttest.

Pretests. A vocabulary test following the procedures outlined in Anderson and Freebody (1981) was used as an overall measure of general verbal ability (Anderson-Freebody Vocabulary Test). The test consisted of 30 target words, 31 general vocabulary words, and 63 non-word distractors. Target items were content-specific words that appeared in the texts the subjects read. General vocabulary words and non-word distractors were

randomly selected from a pool of items demonstrated to have discriminative power (Anderson & Freebody, 1981).

A 15-item prior knowledge test was constructed to assess students' familiarity with insect-eating plants. The test consisted of five questions from three question categories: general topic, literal, and inferential. General topic questions were designed to assess students' general knowledge of plants. Literal and inferential questions were designed to assess students' level of understanding of insect-eating plants.

Text Materials. Four texts, 1250-1800 words in length, were generated in order to compare the differential contributions of both macro and microstructure on reading comprehension. Each text was written with a "considerate" (+) or "inconsiderate" (-) version of macro- or microstructure. Consequently, four texts were produced with various combinations of considerate and inconsiderate text structures. Since these texts were written following the Frayer model of macrostructure (F+) and the Davison and Kantor (1982) suggestions for microstructure (D+), the texts were labeled accordingly: F+D+, F-D+, F+D-, F-D-.

Each text contained four concepts common to all insect-eating plants: habitat, allurement, entrapment, and digestion. Specific information about these concepts was taken from several children's books. Each concept was defined in all four text versions. Each time a concept was introduced in an upgraded text version, it was defined by identifying five different dimensions: (a) relevant attributes, or shared characteristics (e.g., a sweet

fragrant juice is a relevant attribute of the allurement concept for all insect-eating plants), (b) irrelevant attributes, or specific characteristics (e.g., geographic location is an irrelevant attribute of the habitat concept since insect-eating plants may be found in many different places), (c) examples, or representations of concepts that show relevant attributes (e.g., color and scent are examples of allurement features of insect-eating plants), (d) nonexamples, or representations of concepts that lack relevant attributes (e.g., the fact that some green plants use color and odor to discourage intruders is a nonexample of how insect-eating plants use those features), and (e) related concepts, or the building of hierarchial concept structures (e.g., the fact that insect-eating plants get essential chemicals from the food they capture and digest relates the concepts of entrapment and digestion in a coordinate position).

A number of microstructure features were manipulated to determine their effect on reading comprehension. These manipulations were based on the suggestions outlined by Davison and Kantor (1982). Specifically, the micro-structure features employed were: (a) clausal connectives, (b) content connective information, and (c) point-of-view. These features, as well as the macrostructure features, were manipulated to produce the different text versions.

The four text versions were actually created by first writing what we thought was the most considerate text (i.e.,

F+D+) we could write by incorporating text features consistent with the Frayer model and Davison and Kantor's work. Macro- and microstructure features were downgraded to produce the other three text versions.

Macrostructure was downgraded by systematically eliminating the instances of the following features: irrelevant attributes, examples, nonexamples, and related concepts. The following excerpts illustrate some of the macrostructure differences between the F+D+ and F-D+ text versions. These are presented in examples (1) and (2) respectively.

(1) Since insect-eating plants depend on a partial diet of insects for nourishment, the capture cannot be hit-or-miss. Insect-eating plants lure their victims by some sure means of attraction based upon a tempting scent, color, or a combination of scent and color. For example, some varieties of insect-eating plants give off the fragrance of violets, roses, or honey. Other species radiate sparkling red colors. In contrast to some green plants that use color and odor to discourage intruders, the survival of insect-eating plants depends on their capacity to attract prey. (F+D+)

(2) These plants lure their victims by some sure means of attraction based upon a tempting scent, color, or a combination of scent and color. The survival of insect-eating plants depends on their capacity to attract prey. (F-D+)

Microstructure was downgraded in the following manner: (a) deletion of clause connectives to split one sentence into two,

(b) deletion of content connective information to shorten sentences, and (c) change point-of-view by removing any direct second-person references to the reader. Examples (3) and (4) illustrate the changes employed in F+D- and F-D- text versions when these rules were applied to the F+D+ and F-D+ texts, respectively.

(3) Insect-eating plants depend on a partial diet of insects for nourishment. The capture cannot be hit-or-miss. These plants lure their victims by some sure means of attraction. They use a tempting scent, color, or a combination of scent and color. Some varieties of insect-eating plants give off the fragrance of violets, roses, or honey. Other species radiate sparkling red colors. Some green plants use color and odor to discourage intruders. The survival of insect-eating plants depends on their capacity to attract prey. (F+D-)

(4) These plants lure their victims by some sure means of attraction. They use a tempting scent, color, or a combination of scent and color. The survival of an insect-eating plant depends on its capacity to attract prey. (F-D-)

Posttests. A number of posttests were produced to assess students' comprehension of the text they read. The tests were administered in the following order: (a) 7 open-ended questions keyed to macro-level information contained in the Frayer model manipulations, (b) 15 multiple choice questions keyed to information involved in the microstructure manipulations,and (c) 1 blank information matrix to assess macro- and micro-

manipulations. Seven open-ended questions were formulated to assess the impact of Frayer model alterations of text on readers' comprehension of information. The questions were based on information common to all versions of the text, and focused on the method of concept definition for each presentation of the concepts habitat, allurement, entrapment, and digestion. Six of the seven questions were designed to assess concept learning about specific types of plants (i.e., Venus Flytrap, Sundew, Pitcher Plant), and one question was derived from the introductory paragraph in each text. For example, in order to respond correctly to the question "What facts about the Venus Flytrap led scientists to believe that insects are attracted to this plant by both color and scent?" students must know the concept of allurement for the Venus Flytrap and the related concept of entrapment. This information appeared in a richer, more highly structured context (Frayer et al., 1969) in the two F+ texts than it did in the two F- texts. Thus, the only difference between the F+ and F- text versions was the amount of organization each text type contained.

In order to assess the effect of changes in text microstructure on readers' concept learning, a 15-item multiple choice posttest, consisting of both factual and inferential questions, was devised. Ten of the 15 questions dealt specifically with microstructure alterations, focusing primarily on causal-conditional connectives common to all four versions of the text (Davison Subtest 1). For example:

Factual Test Item: "What happens when an insect lands on the side of the Pitcher Plant's tube?"

Answer: "It slides down the tube."

Inferential Test Item: "Insect-eating plants could be killed off most easily by using too much:"

Answer: "Insecticide."

The question-answer relationships for these 10 items were explicit in the F+ versions and implicit in the F- versions. The remaining five questions were selected randomly from the pretest (Davison Subtest 2).

The final posttest, an information matrix, was constructed to determine the effect of macro- and microstructure manipulations on students' ability to organize specific factual information found in the texts. The matrix consisted of three rows labeled with the names of the three insect-eating plants discussed in the text, and five columns labeled with five concept names (habitat, allurement, entrapment, digestion, and disposal). The concept of disposal was added when we discovered that this feature was mentioned in our text for each plant. A number of facts pertaining to insect-eating plants and each of the five concept areas were listed below the matrix. Correct choices were interspersed with distractors. Distractors were items that were relevant to plants in general but not specific to insect-eating plants (e.g., tundra). Distractors were mainly used to prevent any wild guessing. Students were asked to match facts with plant

and concept names by writing the numbers of the facts in the appropriate squares.

Procedure

Both pretests (i.e., the Anderson-Freebody Vocabulary Test and the Prior Knowledge Test constructed for the experiment) were administered two days before students read the texts. Students were given a brief description of the pretests as well as an introduction to the written instructions for each test. After the pretests were administered, students were informed that they would be reading passages dealing with the topic of insect-eating plants. Specifically, students were instructed at the outset that (a) the purpose of this study was to help teachers, textbook writers and publishers understand how students learn from textbooks, (b) they would read one of four different versions of the text, (c) the material should be read at the rate at which they normally read, (d) rereading or referring back to the text would not be allowed once they had indicated they were finished reading, (e) they would be given four tasks to complete which varied in length and difficulty, and (f) they should raise their hand as soon as they finished reading and upon completion of each task. Each student read one text version and then completed a series of posttests during a 50-minute period.

Subjects were also told that some of them might find parts of the material difficult to read and that if they found a word they did not know, they should try their best to figure out the

meaning and continue reading. This instruction was used to approximate an independent reading situation.

Scoring. All test measures, except the seven open-ended questions and the information matrix, were scored as correct or incorrect. Several steps were followed in scoring the seven open-ended questions keyed to the Frayer model manipulations. First, a template was established for determining correct responses to the probes. Second, referring to the template, the information contained in each response was placed in one of the following categories: (a) a correct verbatim response or paraphrase of information found in the text, (b) a correct but partial answer or a paraphrase of the appropriate text information, (c) a logical response not derived from information found in the text, (d) an incorrect response derived from information found in the text, and (e) an incorrect response not derived from information found in the text. A response was placed in the first category if the content words that represented arguments or relations were synonymous with the words used in the template. A response which omitted arguments or relations was placed in the second category. Responses which were logical in form but could not be linked to information contained in the template were placed in the third category. The fourth and fifth categories contained responses that were deviations from the text: Incorrect responses that could be linked to the template, and incorrect reponses that could not be linked to the template. An inter-judge agreement of 97% was

attained among three judges; all disagreements were settled in conference.

The information matrix was scored in the following manner: both correct responses and types of errors were determined. The different error types were: (a) plant confusions (e.g., identifying a Pitcher Plant as uniquely indigenous to North and South Carolina, when this is only true of the Venus Flytrap), (b) concept confusions (e.g., identifying reddish color as a means of digestion for the venus flytrap), (c) both plant and concept confusions (e.g., identifying "passive" as an attribute of how the sundew digests insects), and (d) selecting a foil item (e.g., tundra does not belong to any concept or plant). Thus, the information produced subscores for correct responses and for four error categories.

Data Analysis

The design yielded several status variables which could be used to predict or explain variation on the outcome measures: the two subtests of the Iowa Test of Basic Skills (ITBS), the 15-item prior knowledge test, the Anderson-Freebody Vocabulary test score, the total time taken to read the text, and the total time to complete the posttests. All of these were likely candidates to explain variation associated with general verbal ability. As a preliminary step, we examined the intercorrelations among these variables to determine whether or not it would be useful to use more than one of them in any subsequent analysis of covariance. The intercorrelations suggested that any one of the general

verbal ability measures would explain as much variance as the composite. As a double check, regressions using just the Anderson-Freebody vocabulary test versus all status variables were run. After the Anderson-Freebody test score had been entered, no other status variable added a significant amount of explanatory power to the regression equation. Hence we decided to use the Anderson-Freebody vocabulary test score as the single index of pre-experimental verbal ability in any subsequent analysis. It should be remembered that the Anderson-Freebody vocabulary test contains both general and content-specific vocabulary items. Thus, the use of this test is as face-valid a verbal measure as any other available measure.

Using hierarchial regression techniques, an analysis of covariance (ANCOVA) was performed on these data. The Anderson-Freebody vocabulary test, the covariate, was entered in Step 1. In Step 2, the three contrasts were allowed to compete: Contrast 1 tested the two groups that received the position valence of the macro-alterations (F+D+ and F+D- versus F-D+ and F-D-). Contrast 2 tested the two levels of the micro-alterations within the positive valence of the Frayer-macro conditions (F+D+ versus F+D-) and Contrast 3 tested the two levels of micro-alterations within the negative valence of the Frayer-macro conditions (F-D+ versus F-D-). In Step 3, the interactions between the covariate and the three contrasts were entered step-wise and allowed to compete.

When interactions were not significant, the main effects of the Anderson-Freebody Vocabulary Test and the contrasts were evaluated unambiguously. When interactions were significant, a secondary analysis was conducted. In the secondary analyses, separate regression equations were computed for each level of the contrast, using the Anderson-Freebody Vocabulary Test as a predictor variable for the appropriate dependent measure. We then attempted to explain the interactions in terms of the differential slopes of various separate regression lines.

Results

Our initial data analyses provided a number of findings that could not be explained (e.g., Contrast 3 x Anderson-Freebody score negative interactions) which led us to suspect possible outliers in our data. As we suspected, an outlier was discovered. This particular subject had one of the lowest Anderson-Freebody scores and attained among the highest scores on all posttest measures. Consequently, all data analyses were redone with the outlier removed. All of the significant interaction effects which could not be explained became non-significant. Moreover, the main effects that were significant in the first analyses became stronger. In order to provide a general overview, some descriptive statistics are presented in Table 1 and Table 2.

Insert Tables 1 and 2 about here.

The only analyses which turned out to be statistically significant involved two of three comprehension indices. A general observation across all three main analyses is that the Anderson-Freebody variable accounted for the lion's share of the variance in each case: Frayer-macro test = 33%, Davison-micro Subtest 1 = 40%, Information Matrix = 30%. This is to be expected since the test not only measures general verbal ability but also includes an assessment of knowledge of specific terms in the passages read by all students.

The regression analysis for the Frayer-macro test (see Table 3) yielded two statistically significant effects. In addition to the Anderson-Freebody effect, Contrast 1 (i.e., F+ vs. F-) was found to be significant, explaining 6% of the variance. Regardless of verbal ability, students reading F+ text versions performed better than those students reading F- text versions. Thus, the Frayer-macro test was sensitive to the text manipulations, and students reading the F+ text versions found their texts to be more comprehensible than students reading the F- text versions.

Insert Table 3 about here.

The regression analysis for the Davison-micro test (see Table 4) revealed only an effect for the Anderson-Freebody score. All other analyses with respect to the Davison-micro test proved to be non-significant. These results may have occurred for two

reasons: (a) the test was not sensitive enough to measure the implemented microstructure manipulations, or (b) microstructure manipulations do not play a crucial role in memorial comprehension of expository text.

Insert Table 4 about here.

The last regression analysis (see Table 5) for scores on the Information Matrix, yielded the usual Anderson-Freebody effect and a main effect for Contrast 1, explaining 14% of the variance. The effect for Contrast 1 indicates that, in general, students reading the F+ text versions performed better on this test than those reading F- versions. As can be reasonably inferred from the two regression equations in Table 5, the advantage of reading a F+ text version is greatest with students of low verbal ability and decreases as verbal ability increases. Thus, the Information Matrix and the Frayer macro-test was sensitive to the Frayer-macro manipulations. While the interaction between Contrast 1 and test performance was non-significant, this may have been due to our small sample size and the disproportionate number of students of high verbal ability. These data, then, suggest support for the Frayer-macro text manipulations but not the Davison-micro manipulations.

Insert Table 5 about here.

Discussion

These data permit certain limited conclusions about the effects of text alterations upon different indices of comprehension. Of course, the dominant effect in the whole set of analyses is the powerful effect of verbal ability on all three main indices of comprehension. The other pervasive result was the Contrast 1 effect for both the Frayer-macro test and the Information Matrix. These results suggest that the Frayer-macro manipulations played a role in text comprehension for readers of varying ability. Specifically, they suggest that providing students with examples, relevant attributes, and explicit inter-category comparisons (e.g., "unlike the Venus Flytrap, the Sundew . . .) may help them organize clusters of related and potentially confusing concepts and attributes. Also, it is interesting to note that the relative benefit of the F+ text versions on the information matrix diminishes as verbal ability increases. Perhaps good readers can make sense of even the most botched of texts while the poor readers truly benefit from a text with a considerate macrostructure.

Effects of Davison manipulations and on the Davison micro-test were both negligiable. This result may have occurred for the reasons mentioned earlier. Additionally, we may have just neglected microstructure variables that do have an impact on the comprehension of expository text. The present study, however, offers a tentative conclusion that microstructure text variables do not have a large impact on reading comprehension (consistent

with Neilsen, 1981). Thus, within limits, the manner in which ideas are expressed in terms of microstructure variables does not seem to make a significant impact on children's reading comprehension.

The main finding of the benefit of considerate macrostructure appears not to be in complete agreement with some recent research. Taylor and Samuels (1983) have found that readers who were unaware of text structure did not recall any more information from a well-defined text than they did from scrambled passages. The findings of the present study appear to be inconsistent with Taylor and Samuel's findings since our data demonstrated a significant effect for the F+ versus F- comparison, indicating that all readers (regardless of verbal ability) benefited from a considerate text. While the results of Taylor and Samuels (1983) appear to be inconsistent with some of the findings of the present study, it should be remembered that their study involved a different grade level than the present study (i.e., fifth vs. seventh). Hence, there may be a lower threshold where students are unable to benefit from a well-defined text organization. Such a lower threshold construct is indirectly suggested by Stein, Bransford, Franks, Vye, and Perfetto (1982), who found that "less successful" students lack certain strategies to deal with text that had been organized in an arbitrary manner. After training less successful students to recognize text organization, these students became more effective in evaluating "the precise elaborations that they read or what

they produce on their own" (p. 413). Since Taylor and Samuels (1983) were able to rule out an inferior memory as a significant contributing factor, the relationship between general verbal ability and sensitivity to text structures might be considered. While the present study did not reveal an interaction between general verbal ability and Frayer test performance, the trend of a diminishing benefit as verbal ability increases is noteworthy. This trend suggests that students of low verbal ability can benefit most from a well-defined text. Further, the relative benefit from reading a well defined text decreases with increasing verbal ability. This seems to suggest that there is an upper threshold; i.e., students of high ability will comprehend a text in spite of its poor organizational structure. Thus, four conclusions may be drawn from the above: (a) readers aware of text structure will recall more from an expository passage then those who are unaware; (b) readers can be trained to use text structures in recalling information; (c) there may be a set of prerequisite abilities necessary to benefit from reading a well defined text regardless of verbal ability; and (d) among students of high verbal ability there is a trend of diminishing returns in terms of the benefit from reading a text with a well defined text structure.

In another study, Franks, Vye, Auble, Mezynski, Perfetto, Bransford, Stein, & Littlefield (1982), found that less successful students comprehended explicit text as well as successful students. This equality, however, was not maintained

when the same less successful students were given an implicit text. Thus, there are other text variables which should be considered in conjunction with text organization in studies of this kind. Even though there are differences between the present study and studies mentioned above, their results can be compared on the issue of text organization. The evidence presented in these studies seems to suggest that in addition to sensitivity to text structure, students need a rudimentary set of skills in order to deal with a text effectively.

The present data should also help those who prepare expository texts for students. Overall length (the longer texts were better understood) and traditional indices of readability may not be as critical as are heuristics for making the presentation of concepts and their relationships clearer. It seems, then, that such texts might play a dual role in instruction: (a) to convey information, and (b) to nurture or train students to become more sensitive to and capable of using text structures, i.e., become better readers. The dilemma of reading to learn versus learning to read might then be easier to deal with in the future.

In summary, we can say that we have found some support for extending Peters' findings into science content, that macro- rather than microstructural alterations appear more powerful, and that prior knowledge and incoming verbal ability are powerful determinants of one's ability to learn from text, even very considerate text.

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Table 1

Posttest Means and Standard Deviations by Text Condition

Text Condition	Frayer Test Score		Davison Total Test Score		Davison Subscore		Test Grid Score Total		Proportion of Correct on Test Grid	
	M	SD	M	SD	M	SD	M	SD	M	SD
F+D+	20.82	4.86	8.09	3.53	5.00	2.41	16.91	4.87	.72	.15
F+D-	20.40	6.75	10.00	2.40	6.20	1.75	19.70	4.30	.80	.14
F-D+	17.25	6.34	9.17	2.44	5.33	1.92	15.17	5.83	.67	.21
F-D-	19.22	3.31	8.88	1.69	5.44	1.01	14.78	2.73	.76	.15

Table 2

Intercorrelations of the Major Dependent Variables

	1	2	3	4	5	6	7	8	9
1		.87	.86	.49	.53	.66	.65	.51	.48
2			.86	.52	.54	.76	.71	.53	.37
3				.60	.57	.69	.63	.54	.44
4					.56	.62	.47	.41	.38
5						.60	.57	.78	.54
6							.93	.62	.44
7								.59	.50
8									.64
9									

Note. 1 = Iowa Test of Basic Skills Vocabulary test score
2 = Iowa Test of Basic Skills Comprehension test score
3 = Anderson-Freebody vocabulary test score
4 = Prior knowledge test score
5 = Frayer test score
6 = Davison total test score
7 = Davison subtest 1 score
8 = Total correct on Matrix
9 = Proportion correct on Matix

Table 3

Regression Effects: Frayer-Macro Test Score

Step	Source of Variance	df	R^2 Change	F
1	Anderson-Freebody Vocabulary Test	(1,41)	.330**	19.70
2	Contrast 1 (F+D+ & F+D-) vs. (F-D+ & F-D-)	(1,38)	.062*	4.05
	Contrast 2 (F+D+ vs. F+D-)	(1,38)	.039	2.65
	Contrast 3 (F-D+ vs. F-D-)	(1,38)	.017[a]	.72
3	Contrast 1 x Andfree	(1,35)	.001	.07
	Contrast 2 x Andfree	(1,35)	.037	2.50
	Contrast 3 x Andfree	(1,35)	.004	.24

Note. Regression equations: F- Y = 16.25X + 7.20
F+ Y = 13.30X + 12.03

[a] Denotes a negative correlation.

* $p < .05$

** $p < .01$

Table 4

Regression Effects: Davison Micro Subtest 1 Score

Step	Source of Variance	df	R^2 Change	F
1	Anderson-Freebody Vocabulary Test	(1,41)	.400**	26.66
2	Contrast 1 (F+D+ & F+D-) vs. (F-D+ & F-D-)	(1,38)	.007	.47
	Contrast 2 (F+D+ vs. F+D-)	(1,38)	.003[a]	.18
	Contrast 3 (F-D+ vs. F-D-)	(1,38)	.000[a]	.00
3	Contrast 1 x Andfree	(1,35)	.001	1.79
	Contrast 2 x Andfree	(1,35)	.014[a]	.44
	Contrast 3 x Andfree	(1,35)	.005	.38

Note. Regression equations: F- Y = 2.72X + 3.56
F+ Y = 6.27X + 1.52

[a] Denotes a negative correlation

*$p < .05$

**$p < .01$

Table 5

Regression Effects: Correct Student Responses on Information Matrix

Step	Source of Variance	df	R^2 Change	F
1	Anderson-Freebody Vocabulary Test	(1,41)	.300**	16.79
2	Contrast 1 (F+D+ & F+D-) vs. (F-D+ & F-D-)	(1,38)	.140**	8.82
	Contrast 2 (F+D+ vs. F+D-)	(1,38)	.002[a]	.14
	Contrast 3 (F-D+ vs. F-D-)	(1,38)	.000[a]	.15
3	Contrast 1 x Andfree	(1,35)	.001[a]	.55
	Contrast 2 x Andfree	(1,35)	.011[a]	.61
	Contrast 3 x Andfree	(1,35)	.010	.643

Note. Regression equations: F- Y = 12.95X + 6.32
F+ Y = 11.61X + 10.74

[a] Denotes a negative correlation

* $p < .05$

** $p < .01$